NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM BORIS

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2 – 4 June 2014

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National Hurricane Center
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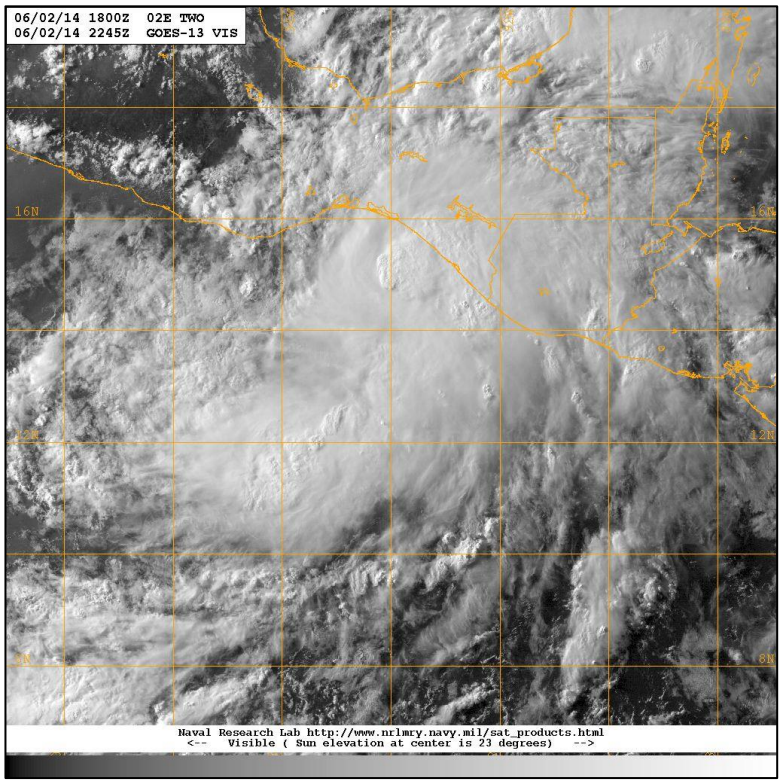

Boris was a short-lived tropical storm that brought heavy rainfall and strong winds to portions of the Pacific coast of southeastern Mexico and Guatemala. Boris weakened to a tropical depression while it neared the coast of Mexico and dissipated over the Gulf of Tehuantepec the next day.

Tropical Storm Boris

2 – 4 JUNE 2014

SYNOPTIC HISTORY

Boris appears to have formed from the interaction of a weak low-level trough and an eastward-moving atmospheric Kelvin wave. The low-level trough moved across Central America late on 28 May and entered the far eastern Pacific Ocean the next day. The trough can only be tracked back to the southwestern Caribbean Sea and it does not appear that it was associated with an African tropical wave. On 30 May, the trough spawned a broad low pressure area about 250 n mi south of the Mexico/Guatemala border. Around the same time, an eastward-moving convectively coupled Kelvin wave passed the longitude of the disturbance. During the next couple of days, the low gradually became better defined while it remained nearly stationary about 250 n mi to the south of Tapachula, Mexico. On 1 June, the low began moving slowly north-northeastward to northward. The next day, thunderstorms associated with the low became more concentrated, and by 1800 UTC 2 June the convection gained enough organization for the system to be analyzed as a tropical depression about 170 n mi south of Tonalá, Mexico. The "best track" chart of the tropical cyclone's path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1[1].

After formation, the tropical cyclone moved northward at about 5 kt between a mid- to upper-level ridge over the west-central Caribbean Sea and a mid- to upper-level trough that extended southwestward from the western Gulf of Mexico into central Mexico. During the next 12 to 24 h, the associated convection gradually became better organized with increased banding over the eastern semicircle of the circulation. The depression is estimated to have become a tropical storm at 1200 UTC 3 June, and Boris reached its peak intensity of 40 kt 6 h later, about 75 n mi south-southwest of Tonalá. Late on 3 June, the bulk of the deep convection moved inland over the Mexican state of Chiapas, but the low-level center remained offshore and the northward motion of the cyclone began to slow. The interaction with land caused the tropical cyclone to weaken, and Boris became a tropical depression by 0600 UTC 4 June when the center was located just offshore of the coast of southern Mexico, about 20 n mi southwest of Tonalá. After weakening and becoming a vertically shallow system, Boris drifted northwestward and remained just off the coast of southern Mexico. The associated convection continued to lose organization and diminished later that day. Boris degenerated to a remnant low by 1800 UTC 4 June and dissipated a short time later over the Gulf of Tehuantepec.

[1] A digital record of the complete best track, including wind radii, can be found on line at ftp://ftp.nhc.noaa.gov/atcf. Data for the current year's storms are located in the *btk* directory, while previous years' data are located in the *archive* directory.

METEOROLOGICAL STATISTICS

Observations in Boris (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB). Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Tropical Rainfall Measuring Mission (TRMM), the European Space Agency's Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Boris.

The estimated 40-kt peak intensity of Boris at 1800 UTC 3 June is based on ASCAT passes at 1524 and 1618 UTC 3 June, which both indicated 37-kt winds to the northeast of the center.

Operationally Boris was thought to have made landfall along the coast of Chiapas near Tonalá around 0600 UTC 4 June. Visible satellite imagery later that day, however, suggests that the low-level center remained offshore. This was later confirmed by an 1835 UTC microwave satellite image (Fig. 4) that showed the low-level cloud swirl over the Gulf of Tehuantepec. The final best-track indicates that Boris came within about 20 n mi of the coast before weakening and turning northwestward over the Gulf of Tehuantepec.

Although no reports of tropical-storm-force winds were received from land-based observing sites in southeastern Mexico, tropical-storm-force winds likely occurred along portions of the immediate coast of Chiapas. The aforementioned ASCAT data showed that tropical-storm-force winds were occurring just offshore, and these winds likely spread northward and affected portions of the immediate coast of Mexico late on 3 June and early on 4 June.

There were no ship reports of winds of tropical storm force associated with Boris, although several pressure observations from ships were useful in estimating the minimum central pressure of the tropical cyclone on 2 and 3 June.

Rainfall amounts of 4 to 8 inches (100-200 mm) were reported at many observing sites in the states of Chiapas, Campeche, Tabasco, Oaxaca, and Veracruz (Figs. 5 and 6). The maximum rainfall recorded during the 72-h period from 1300 UTC 2 June to 1300 UTC 5 June was 17.91 in (454.8 mm) at Tres Picos, Chiapas. In Tabasco, 15.72 in (399.3 mm) was measured at San Pedro and another observing site near San Pedro reported 13.15 in (334.1 mm). The maximum rainfall amounts in Guatemala were 9.27 in (235.4 mm) at Mazatenango and 9.24 in (234.7 mm) at La Reforma. Selected rainfall totals from Mexico and Guatemala are given in Tables 2 and 3, respectively.

CASUALTY AND DAMAGE STATISTICS

Rainfall associated with Boris and its precursor disturbance produced flooding and several landslides in Guatemala and portions of southeastern Mexico. There have been no reported casualties from Boris while it was a tropical cyclone, although the national coordinator

for disaster reduction in Guatemala reported that five people were killed and seven others injured in the town of San Pedro Necta from a landslide caused by heavy rains associated with the precursor disturbance. The coordinator also indicated that about 100,000 people were affected by flooding in Guatemala and 223 homes were damaged. Figure 7 shows an example of the flood damage that occurred near Guatemala City. Media reports indicate that the flooding in Mexico did not produce widespread damage.

FORECAST AND WARNING CRITIQUE

The development of Boris was well predicted. The potential for tropical cyclone formation south of Mexico was first mentioned in the Tropical Weather Outlook issued at 1200 UTC 29 May, a little more than 4 days before formation. The system was assessed to have a medium (30 to 50%) or greater chance of development in the 5-day forecast period beginning 0000 UTC 30 May, 90 h before genesis. Table 4 indicates how far in advance of formation the NHC Tropical Weather Outlook forecast first reached the indicated likelihood.

A verification of NHC official track forecasts for Boris is given in Table 5a. There were only 6, 4, and 2 forecasts to verify at 12, 24, and 36 h, respectively. For this small sample, the NHC official forecast track errors were comparable to the mean official errors for the previous 5-yr period through 24 h, but were higher than the long-term mean errors at 36 h. A homogeneous comparison of the official track errors with selected guidance models is given in Table 5b. The multi-model consensus TVCE was the only model to outperform the NHC forecasts at 12, 24, and 36 h. At the time of formation, most of the track guidance generally showed a northwestward to northward motion of Boris toward the coast of southern Mexico; however, there were large differences in the predicted forward speed of the cyclone. The GFS and GFS ensemble mean (AEMI) were among the faster models and showed Boris near the coast of southern Mexico in 2 to 3 days. The ECMWF predicted a much slower motion and kept the cyclone well south of the coast for more than 5 days. Although the initial NHC track forecast was between these solutions, it predicted a slower forward motion and a track farther west than what actually occurred.

A verification of NHC official intensity forecasts for Boris is given in Table 6a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period at 12 and 24 h, but a little higher than the long-term average at 36 h. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 6b.

Watches and warnings associated with Boris are given in Table 7.

ACKNOWLEDGEMENTS

Carlos Garrido from Mexico's CONAGUA (Comisión Nacional del Agua, Servicio Meteorológico Nacional) provided rainfall data and maps.

Table 1. Best track for Tropical Storm Boris, 2-4 June 2014.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
01 / 0000	11.4	93.9	1008	20	disturbance[2]
01 / 0600	11.5	93.7	1008	20	"
01 / 1200	11.7	93.5	1007	20	low
01 / 1800	11.9	93.4	1006	20	"
02 / 0000	12.1	93.4	1005	25	"
02 / 0600	12.4	93.5	1004	25	"
02 / 1200	12.8	93.8	1002	25	"
02 / 1800	13.2	94.1	1001	25	tropical depression
03 / 0000	13.6	94.2	1001	30	"
03 / 0600	14.0	94.2	1000	30	"
03 / 1200	14.4	94.2	999	35	tropical storm
03 / 1800	14.9	94.1	998	40	"
04 / 0000	15.3	94.0	1000	35	"
04 / 0600	15.6	94.0	1002	30	tropical depression
04 / 1200	15.8	94.1	1004	25	"
04 / 1800	15.9	94.3	1006	20	low
05 / 0000					dissipated
03 / 1800	14.9	94.1	998	40	maximum winds and minimum pressure

[2] NHC is conducting an in-house experiment in which track, intensity, and size forecasts are prepared for disturbances that are assessed to have a 60% or higher chance of genesis within 48 h. To support the verification of the experimental forecasts, NHC is currently extending the best track of these systems back to the point where the first experimental forecast was made.

Table 2. Selected rainfall totals in Mexico for the 72 h period from 1300 UTC 2 June to 1300 UTC 5 June.

Location and State	Rainfall
Tres Picos, Chiapas (15.88°N 93.53°W)	17.91 in (454.8 mm)
San Pedro, Tabasco (17.79°N 91.16°W)	15.72 in (399.3 mm)
San Pedro, Tabasco (17.77°N 91.15°W)	13.15 in (334.1 mm)
Pijijiapan, Chiapas (15.69°N 93.22°W)	11.63 in (295.5 mm)
Candelaria, Campeche (18.18°N 91.05°W)	10.24 in (260.0 mm)
Palizada, Campeche (18.13°N 92.09°W)	10.24 in (260.0 mm)
Ostuta, Oaxaca (16.50°N 94.40°W)	8.10 in (205.8 mm)
Juan Sabines, Chiapas (15.92°N 92.92°W)	7.59 in (192.9 mm)
Paredon, Chiapas (16.06°N 93.86°W)	7.51 in (190.9 mm)
Jaltipan, Veracruz (17.95°N 94.67°W)	7.33 in (186.3 mm)
Chicomuselo, Chiapas (15.75°N 92.28°W)	7.01 in (178.1 mm)
Tapachula, Chiapas (14.90°N 92.18°W)	6.77 in (172.0 mm)
Boca del Cerro (17.43°N 91.48°W)	6.31 in (160.2 mm)
Champoton, Campeche (19.36°N 90.72°W)	6.22 in (158.0 mm)
El Novillero, Chiapas (17.50°N 92.95°W)	6.02 in (153.0 mm)
Viva Cardenas, Chiapas (16.83°N 93.19°W)	5.88 in (149.3 mm)
Mapastepec, Chiapas (15.45°N 92.88°W)	5.79 in (147.0 mm)
Escarcega, Campeche (18.61°N 90.74°W)	5.67 in (144.1 mm)
Cardenas, Tabasco (17.81°N 93.41°W)	5.51 in (140 mm)

Table 3. Selected rainfall totals in Guatemala during 2-5 June.

Location	Rainfall
Mazatenango (14.53°N 91.50°W)	9.27 in (235.4 mm)
La Reforma (14.77°N 91.84°W)	9.24 in (234.7 mm)
San Lucas Tomimán (14.64°N 91.14°W)	8.91 in (226.4 mm)
San Marcos (14.95°N 91.81°W)	8.69 in (220.7 mm)
Volcán de Fuego (14.46°N 90.96°W)	8.30 in (210.8 mm)
Santa Mariá El Tablón (14.79°N 91.18°W)	7.89 in (200.4 mm)
San Jose Aeropuerto (13.94°N 90.83°W)	7.47 in (189.7 mm)
Santa Margarita (14.51°N 91.01°W)	7.18 in (182.3 mm)
Volcán de Pacaya	6.41 in (162.8 mm)
San Pedro Mactún (17.26°N 90.75°W)	5.97 in (151.7 mm)
Santiago Atitlán (14.63°N 91.23°W)	5.74 in (145.8 mm)
Champerico (14.29°N 91.91°W)	5.56 in (141.2 mm)
Playa Grande (15.99°N 90.74°W)	5.15 in (130.7 mm)
Tecún Umán (14.67°N 91.14°W)	4.79 (121.6 mm)

Table 4. Number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the "Low" category do not include forecasts of a 0% chance of genesis.

	Hours Before Genesis	
	48-Hour Outlook	**120-Hour Outlook**
Low (<30%)	78	102
Medium (30%-50%)	66	90
High (>50%)	42	66

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Boris, 2-4 June 2014. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	**24.3**	44.7	69.4				
OCD5	34.0	72.1	116.7				
Forecasts	6	4	2				
OFCL (2009-13)	25.7	41.4	55.0	68.6	97.8	134.2	167.1
OCD5 (2009-13)	37.2	74.8	118.0	162.5	249.4	332.6	413.3

Table 5b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Boris 2-4 June, 2014. Errors smaller than the NHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	24.3	44.7	69.4				
OCD5	34.0	72.1	116.7				
GFSI	30.8	74.5	**29.2**				
GHMI	43.5	55.1	**55.3**				
HWFI	37.9	71.7	85.6				
EMXI	29.4	51.5	107.4				
CMCI	40.7	65.7	84.5				
NVGI	46.0	103.5	184.9				
GFNI	53.8	100.0	176.4				
AEMI	35.3	54.2	**55.9**				
TVCE	**23.9**	**40.8**	**56.4**				
LBAR	42.6	130.3	226.7				
BAMD	64.4	127.5	176.7				
BAMM	53.8	109.3	151.4				
BAMS	46.5	85.8	128.4				
Forecasts	6	4	2				

Table 6a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Boris, 2-4 June 2014. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	**2.5**	**6.3**	15.0				
OCD5	4.0	7.3	18.0				
Forecasts	6	4	2				
OFCL (2009-13)	6.1	10.4	13.4	14.5	15.0	16.4	16.1
OCD5 (2009-13)	7.7	12.7	16.4	18.8	20.5	20.3	20.8

Table 6b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Boris, 2-4 June 2014. Errors smaller than the NHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	2.5	6.3	15.0				
OCD5	4.0	7.3	18.0				
GHMI	5.7	**3.3**	**11.5**				
HWFI	4.5	8.5	**5.0**				
DSHP	5.0	**3.5**	**10.5**				
LGEM	5.2	**5.3**	**7.5**				
ICON	4.8	**3.8**	**8.0**				
IVCN	4.8	**3.8**	**8.0**				
Forecasts	6	4	2				

Table 7. Watch and warning summary for Tropical Storm Boris 2-4 June 2014.

Date/Time (UTC)	Action	Location
02 / 2100	Tropical Storm Watch issued	Salina Cruz to Mexico/Guatemala border
03 / 0300	Tropical Storm Warning issued	Salina Cruz to Mexico/Guatemala border
04 / 0900	Tropical Storm Warning discontinued	All

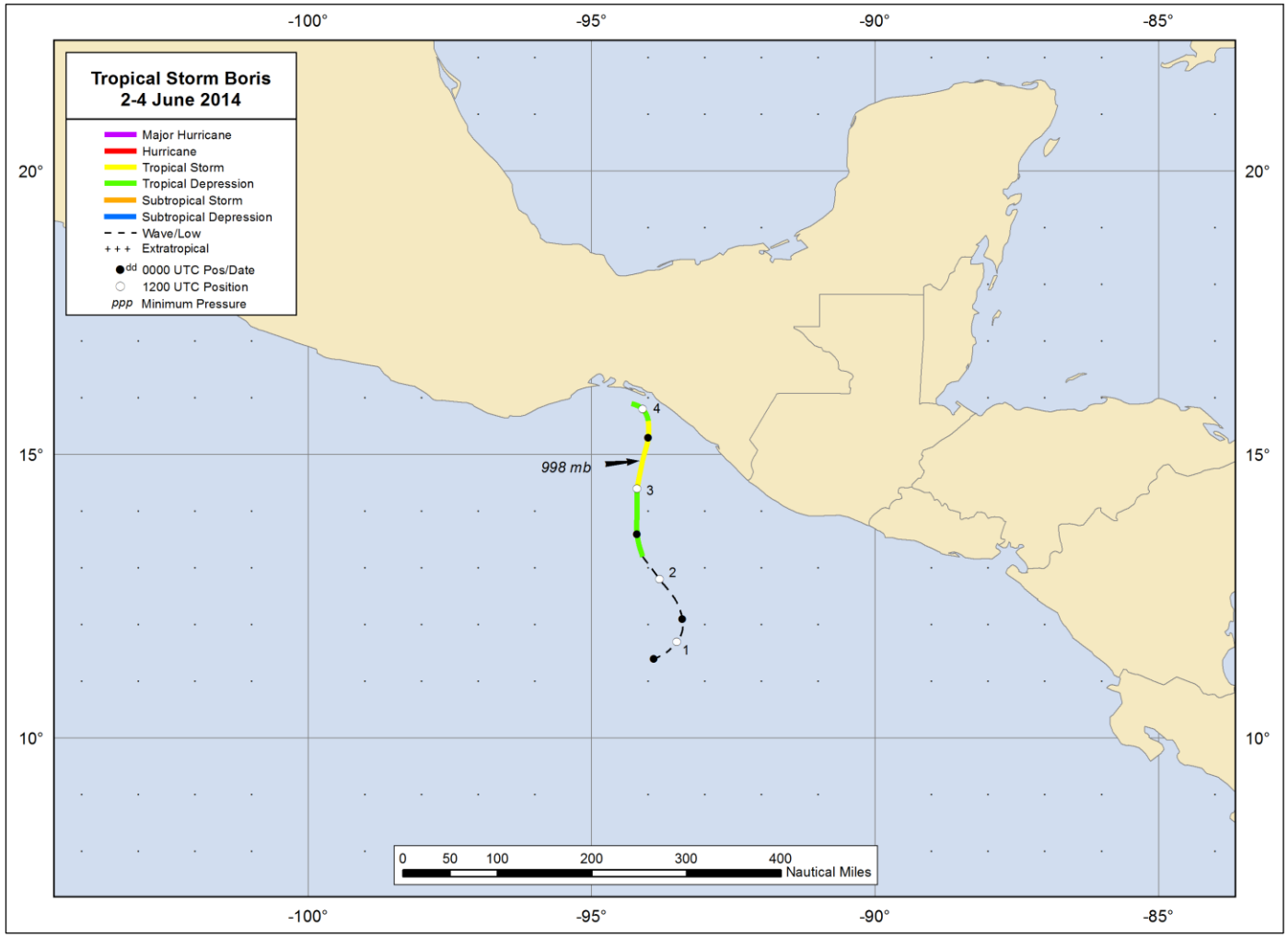

Figure 1. Best track positions for Tropical Storm Boris, 2-4 June 2014.

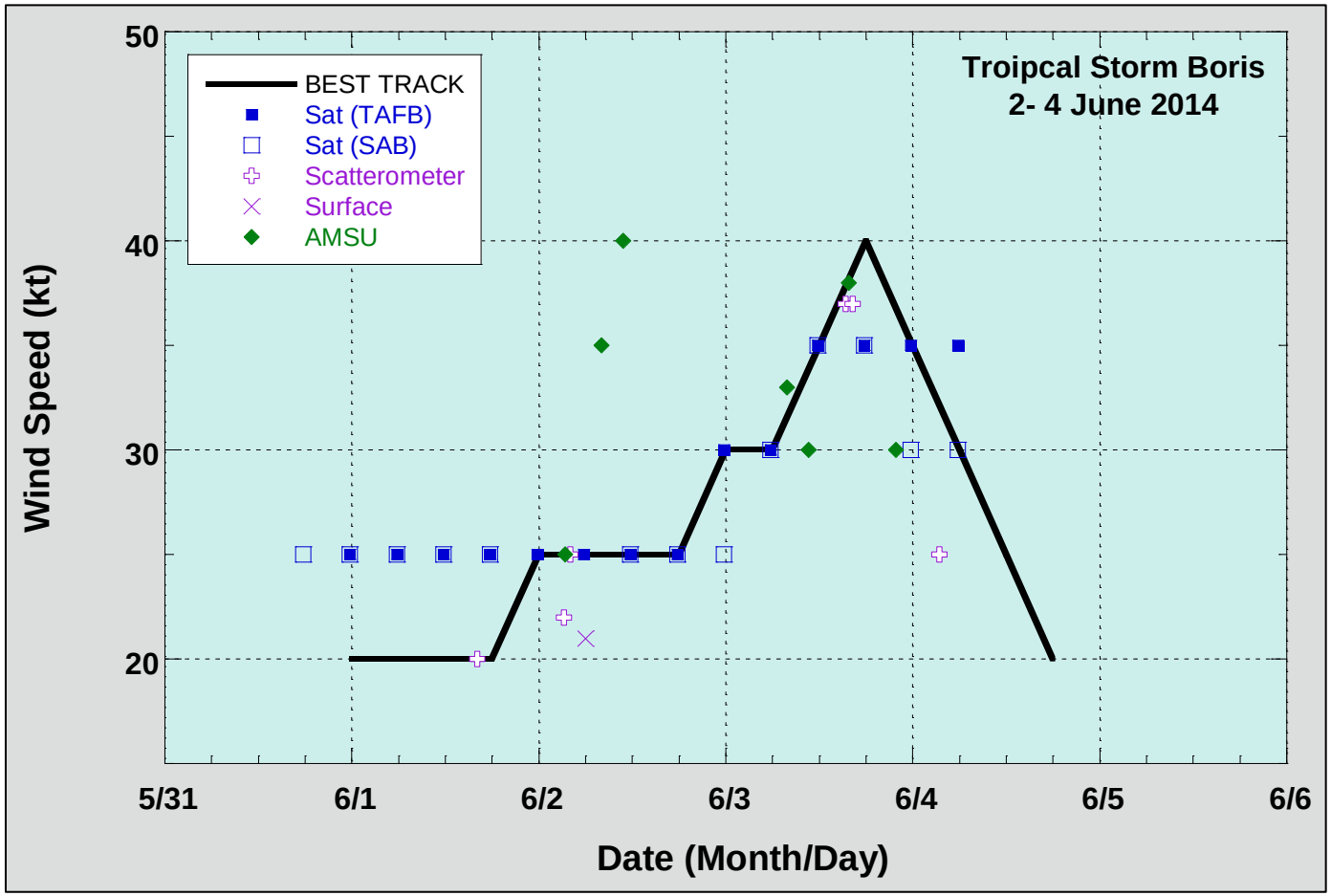

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Boris, 2-4 June 2014. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC.

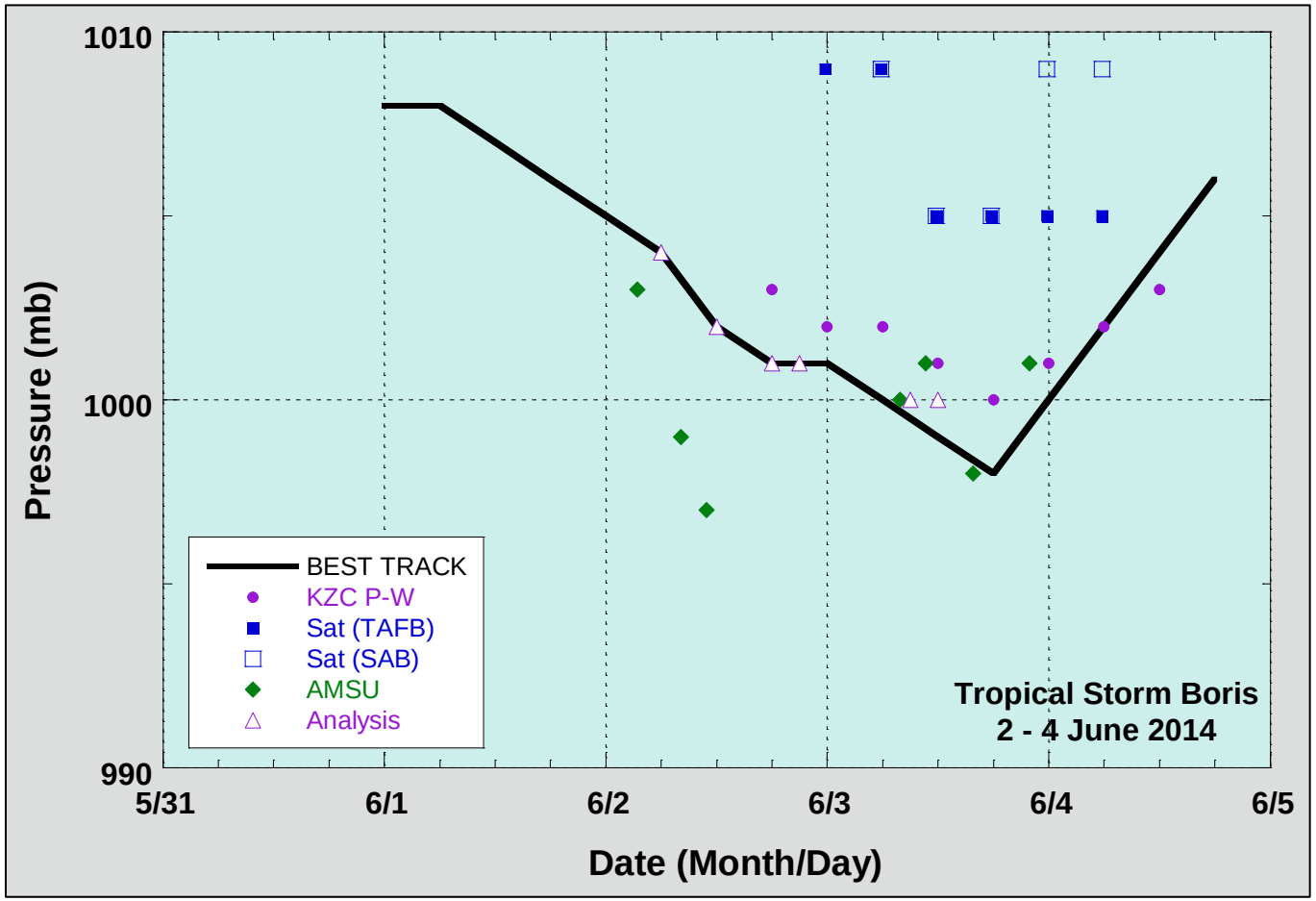

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Boris, 2-4 June 2014. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC.

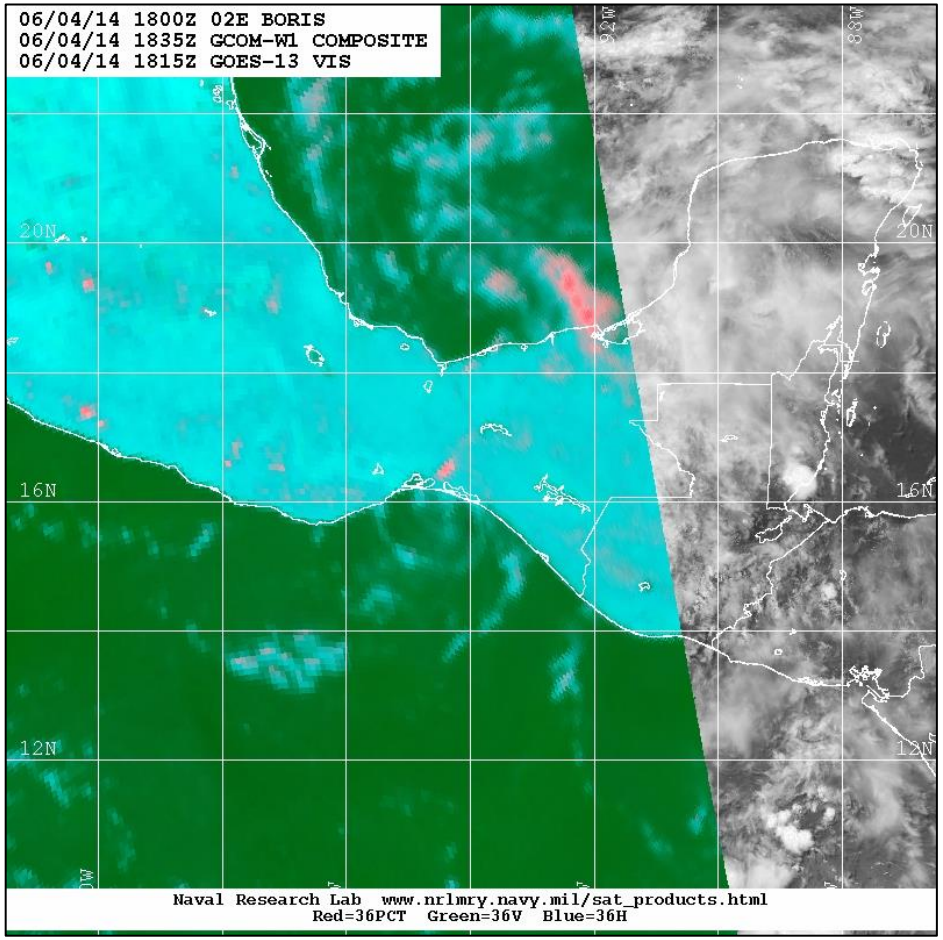

Figure 4. Composite 37-GHz microwave image showing the remnant low of Boris centered over the Gulf of Tehuantepec at 1835 UTC 4 June 2014. The image reveals that the low-level center did not make landfall as indicated operationally. The cyclone instead remained over water and dissipated later on 4 June over the Gulf of Tehuantepec. Image courtesy of the Naval Research Laboratory.

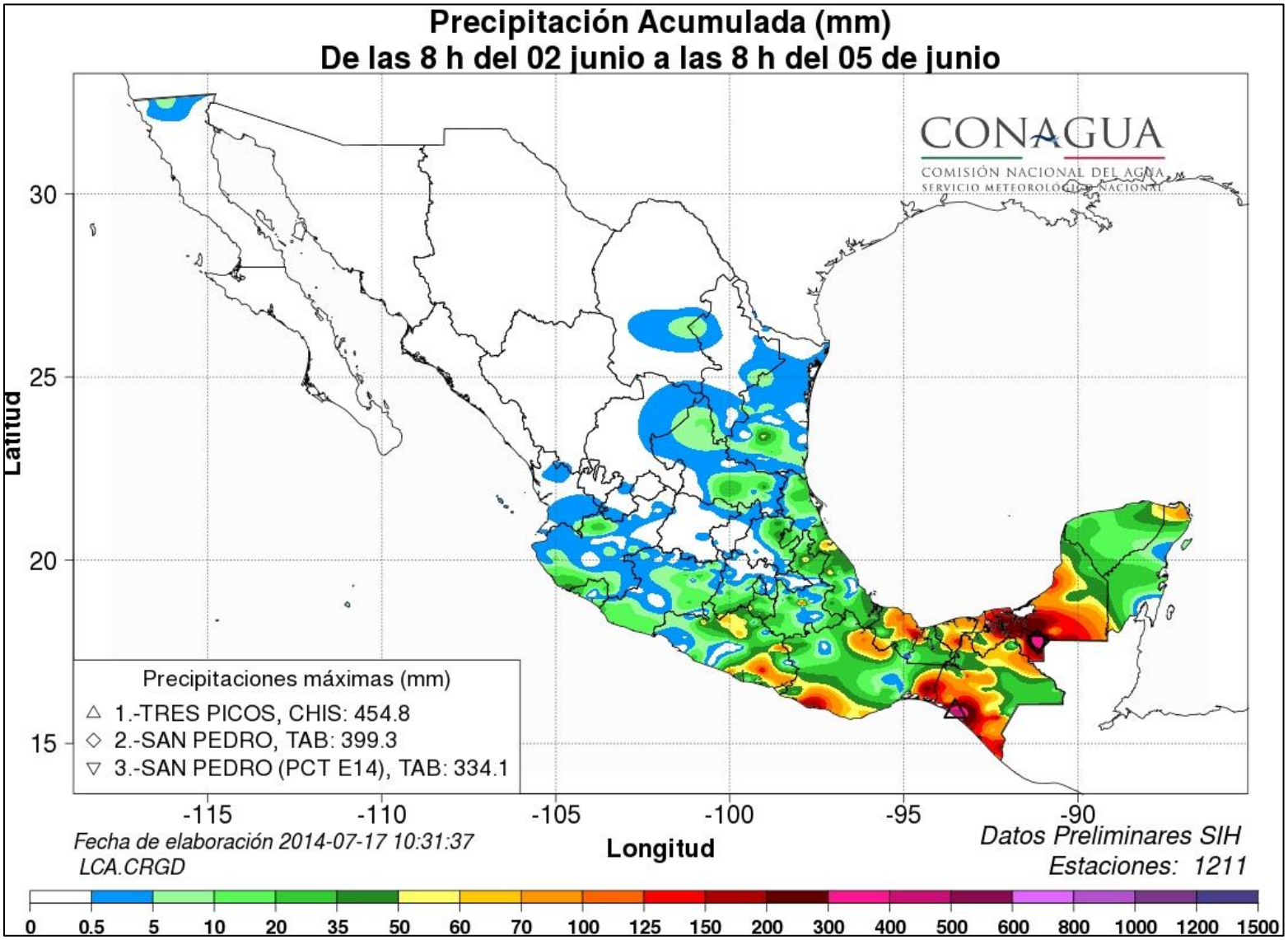

Figure 5. Rainfall accumulations (mm) in Mexico from 1300 UTC 2 June to 1300 UTC 5 June. Rainfall over the southeastern portion of the country during this period was associated with Boris. Map provided by CONAGUA.

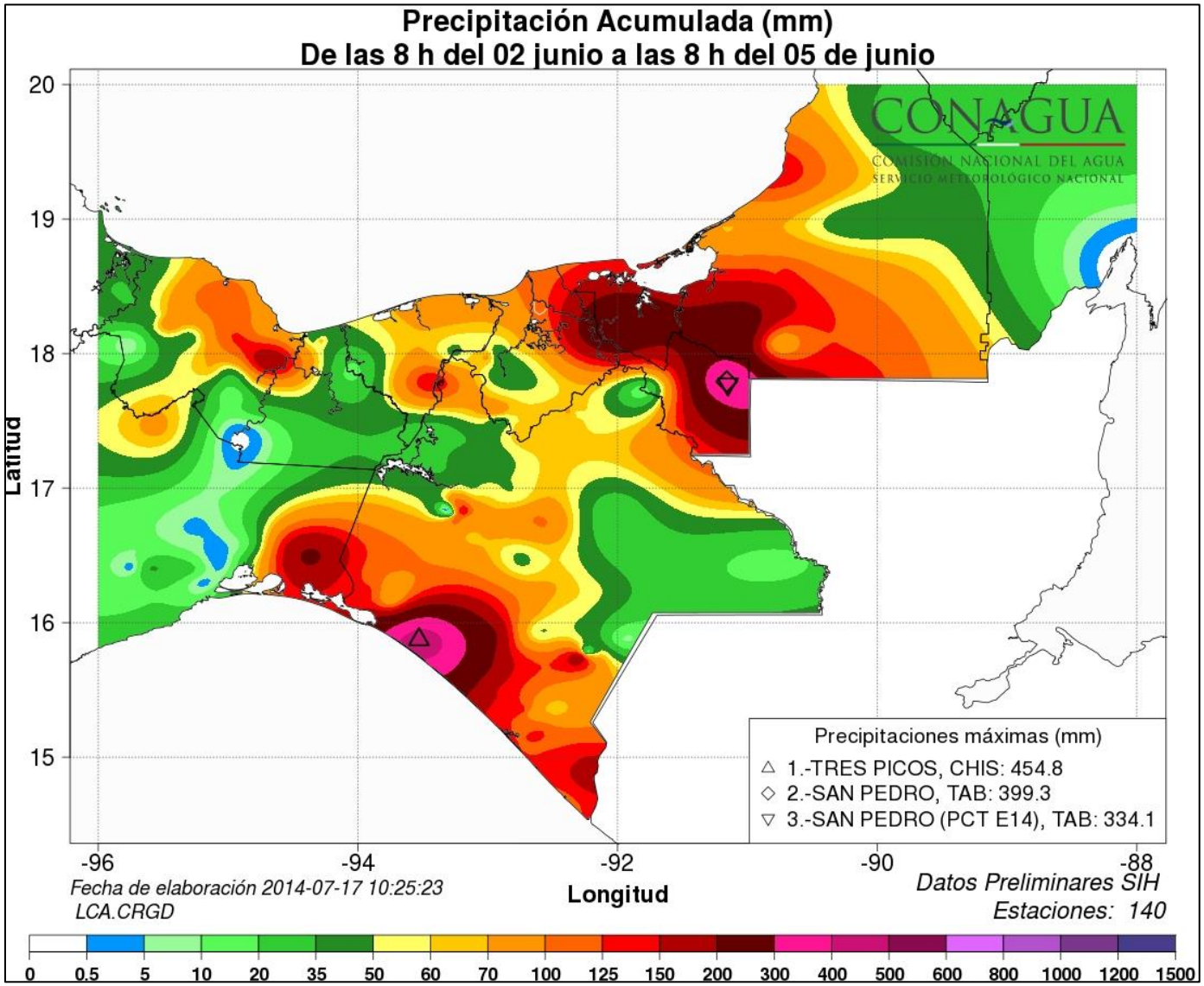

Figure 6. Same as Figure 5 but centered on the states of Chiapas, Tabasco, Campeche, and the eastern portions of Veracruz and Oaxaca. Map provided by CONAGUA.

Figure 7. Flood damage associated with Boris near the town of Villa Hermosa, Guatemala, located about 12 miles (20 km) south of Guatemala City. Photo courtesy of Agence France-Presse (AFP).